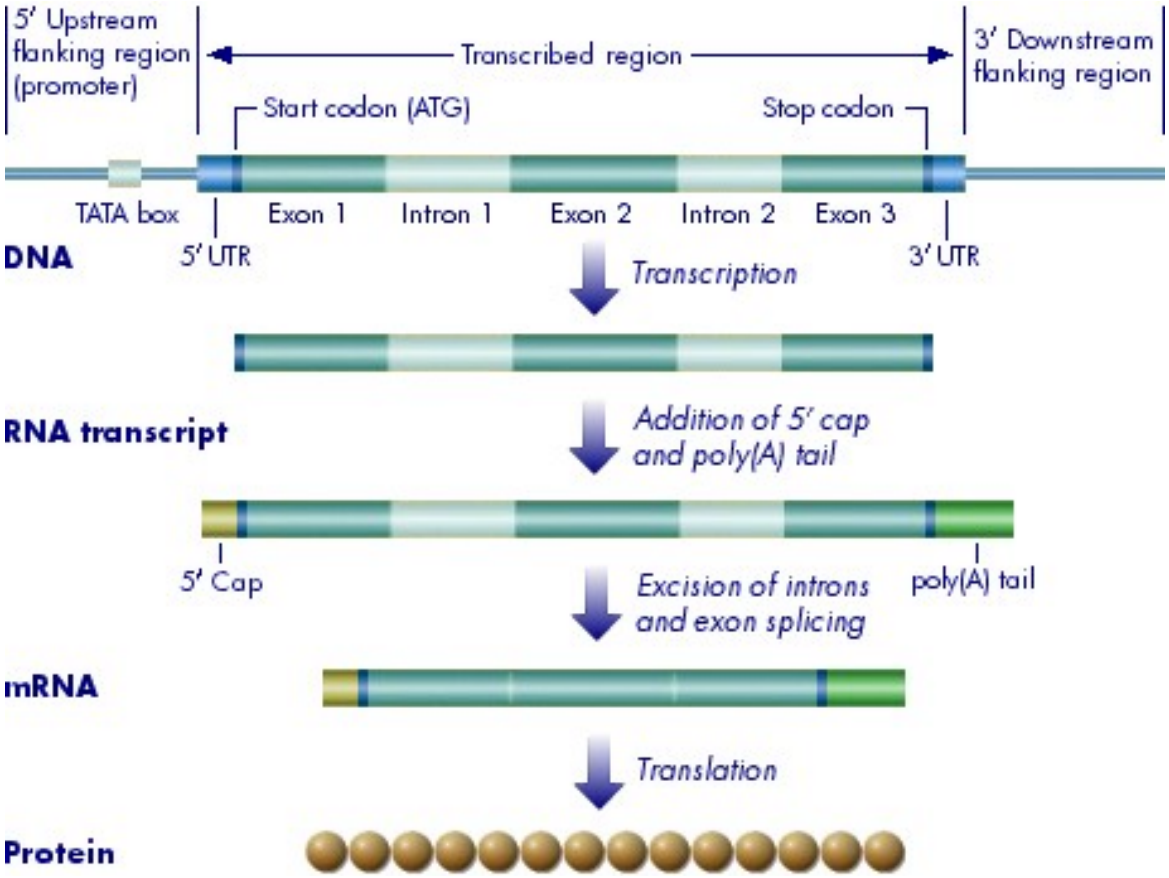
….CGCCATGCTATCGAGCATCGTGCGAGCAGCGATGCGATGCT
AGTAGCTGAGCGCTAGGCTAGCAGTCGCGTAGTCTAGCGACT
AGTGCGACGTACGGCGCGCTAGAGTCGGCTATATCGGAGCGG
GCGCGATTATATATGCGATGAGAAGCGGCCGGCGCGCGCGCG
ACTGATCTATCTAGCATATCGATCTTCTCTAATCGCGCATGCG
ATGCTAGCTGAGCGATCGGACGTAGCGACGGACGATATTATA
TATTCGCGCGGCAGCGGCGCGGCTATATTTATATATTATATAT
TATTATATTAGCGAGCTCTCGATTCTTATATATATAGCATCTGA
GCTGAGCGTATCAGTGCTAGCTGATGCTGTAGTCGATCGTAGC
ATTATATATATATATTATAGCGATCGGCGCGCGCGCGATCG
TAGCTGCTGTGTGTGTCAAAGCGATTCTATATATATTTTCGAG
CTAGGAGCGCGGCGCCCCGATGCTCGAACTAGCGAGCTGAGC
GACGAGCGAGCGACGGCGACTAGGCAGGCAGCGAGCTATTAA
TTTATTAGCGACGCTAGTCGAAAATACGAGGCGCGCGCCATA
CGGATTACGCTAGCGATTATGGGCCCCGGCGCGCGTAGCTGCT
GATGCTGTCGTGTGATCGGTGATGCGAGCGCGGCCGCGGCGG
CGCGATGTAGCTGATCGTAGTGTATGCGCGCGCGTAGCTTTAT
ATCGTAGTGCTCGTGTGACACACACACGATCGTAGCTGATCGA
TGCACCATGCTAGCAGCTACGTTGCGATCGCGCTAGCTAG…..

Organism	Number of predicted genes	% of Genome that encodes proteins
E. coli (bacteria)	5,000	90%
S. cerevisiae (yeast)	6,000	70%
C. elegans (worm)	18,000	27%
D. melanogaster (fly)	14,000	20%
A. thaliana (plant)	25,500	20%
Homo sapiens (human)	35,000	< 5%

Adapted from www.ebi.ac.uk/microarray/_biology_intro.htm

See: Molecular Biology of the Cell, Alberts et al., 4th Edition

Figure 4–17 Representation of the nucleotide sequence content of the human genome.



Gene expression differences

Ubiquitous expression
"house-keeping" genes

↓

Genes expressed at
relatively constant levels
in nearly all cell types

↓

Proteins often involved
in cell metabolism

Differential gene expression

↓

Genes expressed in a subset
of cell types (tissue specific)
OR only at certain times
(developmental, regulated)

↓

Proteins often have very
specialized functions

GAPDH: Glyceraldehyde-3-phosphate dehydrogenase

skin; brain; lung; lymph; ovary; placenta; uterus; breast; stomach; eye; colon; kidney; testis; pancreas; cervix; liver; prostate; b-cells; marrow; salivary gland; heart; muscle; head_neck; eye, retina; colon; adrenal gland; lymph, t-cell; chondrosarcoma; fetal pancreas; leiomios; brain, hippocampus; kidney_tumor; breast cancer; aorta,endothelium; bladder_tumor; osteoarthritic cartilage; prostate_normal; hepatocellular carcinoma; bone; epid_tumor; gall bladder; bladder; lens; foreskin, melanocyte; pooled colon, kidney, stomach; thymus; lung metatastic chondrosarcoma; placenta_normal; uterus_tumor; whole embryo; uterus; nervous_normal; testis, cell line; fibrosarcoma; brain, pituitary gland; b cells from burkitt lymphoma; ovary; blood; cartilage; lung, neuroendocrine lung carcinoids; pancreas, islet; adipose, white adipose tissue; brain, amygdala; retina; larynx; lung epithelial cells; trabecular meshwork; rpe and choroid; testis, epididymus; pancreas, exocrine; colon; spleen; retina; bone marrow stroma; prostate, epithelium; head_normal; omentum; pituitary; muscle, skeletal muscle; uterus, epithelium; lung with fibrosis; eye anterior segment; ear, cochlea; placenta; bone, synovia; pooled pancreas and spleen; lymph, b-cell; bone, trabecular bone cells; prostate, metastatic prostate; bone lesion; tonsil, germinal center b-cells; brain, pineal gland; lung_tumor; brain, cerebellum; muscle (skeletal); breast_normal; germ cell; amnion_normal; sympathetic trunk; esophagus; brain, hippocampus ; testis_normal; muscle, striated; pnet; umbilical cord, endothelium; hypothalamus; cord blood; lung, cell line; parathyroid; tongue; uterus, endometrium; nervous_tumor; bone marrow; non cancerous liver tissue; whole blood; brain; fetal brain; colon_normal; synovial membrane; optic nerve; head and neck; umbilical cord vein, endothelium; fetal eye; brain, miningioma; aorta; lymph node; leukocyte; foveal and macular retina; connective tissue; placenta; brain, pituitary; genitourinary tract; eye, ciliary body; lung; prostate tumors ; skin, melanocyte; brain, astrocytoma; nose, olfactory epithelium; thyroid; blood, lymphocyte; germ

Gene expression differences

Ubiquitous expression
"house-keeping" genes

↓

Genes expressed at
relatively constant levels
in nearly all cell types

↓

Proteins often involved
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Differential gene expression

↓

Genes expressed in a subset
of cell types (tissue specific)
OR only at certain times
(developmental, regulated)

↓

Proteins often have very
specialized functions

GJB2: Gap junction protein, beta 2, 26kD (connexin 26)

head_neck;skin; colon;ear, cochlea; brain; stomach; lung;ovary, epithelium;human eye anterior segment;esophagus;germ cell; uterus; nervous tumor; kidney; pool, liver+spleen; pancreas, exocrine; leiomios; pooled colon, kidney, stomach; bladder; testis; whole embryo;ovary; uterus, pooled; uterus, epithelium; heart; hepatocellular carcinoma; prostate; colonic mucosa with ulcerative colitus

TECTA: Tectorin alpha

brain; testis; ear, cochlea

Sites of Noggin Gene Expression

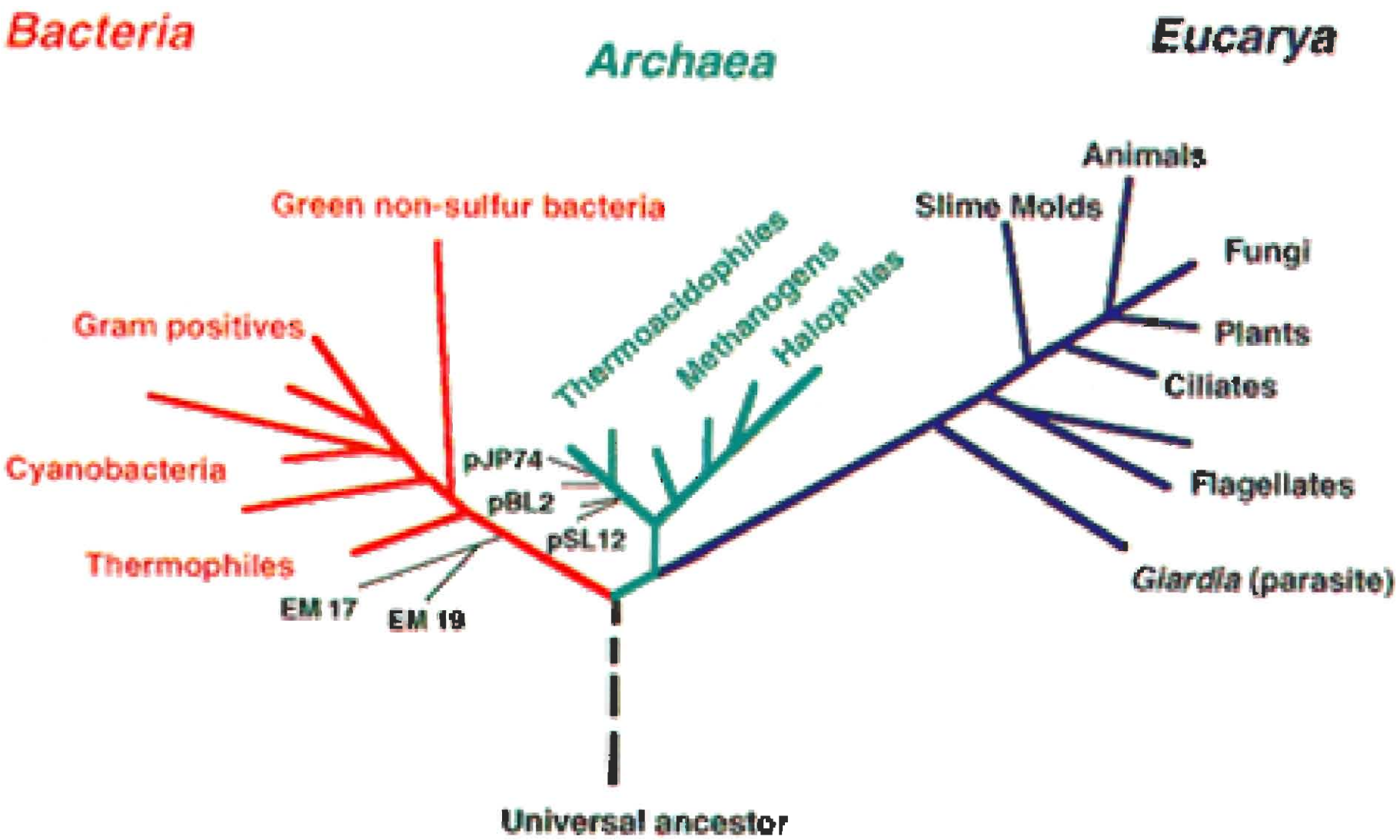
See Brunet, L. J., McMahon, J. A., McMahon, A. P., Harland, R. M. (1998) *Science*. 280, 1455-1457.

Alba: A genetically engineered white rabbit that glows in the dark

http://abcnews.go.com/media/OnAir/images/ho_alba_green_000918_h.jpg

Alternative RNA splicing

See: http://www.pitt.edu/~biohome/Dept/Img/graphics/grabowski/altsplice.jpg



THE UNIVERSAL TREE OF LIFE

Charles Darwin

1809 - 1882

Human-Mouse Homology Map

See: Molecular Biology of the Cell, Vol. 4, Alberts *et al.*

Figure 4–18 Conserved synteny between the human and mouse genomes.

Additional Readings

Molecular Biology of the Cell, Vol. 4, Alberts *et al*.